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10EC55

Fifth Semester B.E. Degree Examination, Aug./Sept. 2020
Information Theory and Coding

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Find an expression for average information content of symbols in long independent sequence and prove that $H(s)_{max} = \log_2 M$ when all 'M' symbols are equally likely independent. **(06 Marks)**

b. State diagram of stationary mark off source is given in Fig.Q1(b). Calculate H, G_1, G_2 and verify that $G_1 > G_2 > H$.

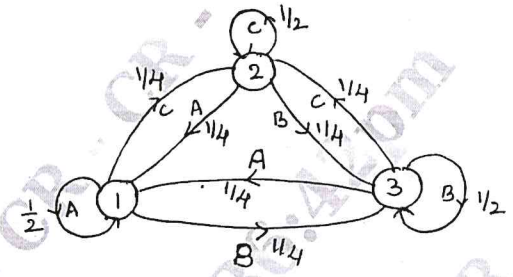

Fig.Q1(b) **(14 Marks)**

2 a. For a discrete memoryless source of entropy H(s). Show that the average code word length (L) for any distortionless source encoding speed is bounded by $L \geq H(s)$. **(06 Marks)**

b. A source has 6 symbols with probabilities P1 to P6 such that $P_1 = P_2 > P_3 = P_4 > P_5 = P_6$. If $P_6 = \frac{1}{12}$ construct Shannon code for the above messages and determine the efficiency of the code. **(07 Marks)**

c. Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02. Construct a quaternary compact code and determine the code efficiency. **(07 Marks)**

3 a. Prove that mutual information is always non-negative i.e $I(A, B) \geq 0$. **(08 Marks)**

b. A channel has the following characteristics

$$P(Y/X) = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cccc} y_1 & y_2 & y_3 & y_4 \end{array} \\ \begin{bmatrix} 1/3 & 1/3 & 1/6 & 1/6 \\ 1/6 & 1/6 & 1/3 & 1/3 \end{bmatrix} \end{array}$$

Find H(s), H(Y), H(x, y) and channel capacity if r = 1000 samples/sec. Assume $P(x_1) = P(x_2) = \frac{1}{2}$. **(08 Marks)**

c. List the properties of Noiseless and deterministic channel. **(04 Marks)**

4 a. State Shannon's Hartley law and prove that $C_\infty = 1.44(S/N)$. **(07 Marks)**

b. A Gaussian channel has a bandwidth of 4KHz and a two –sided noise power spectral density $\eta/2$ of 10^{-14} watts/Hz, signal power at the receiver has to be maintained at a level less than or equal to 0.1mW. Calculate the capacity of the channel. **(07 Marks)**

c. A channel diagram and the corresponding channel matrix P(B/A) of a deterministic channel are shown in Fig.Q4(c). Obtain its channel capacity.

$$P(b_j/a_i) = \begin{array}{c} \\ a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \\ a_6 \end{array} \begin{array}{c} \begin{array}{ccc} b_1 & b_2 & b_3 \end{array} \\ \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \end{array}$$

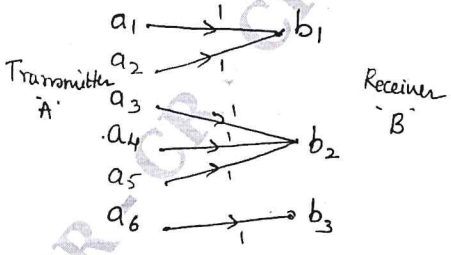

Fig.Q4(c)

(06 Marks)

PART – B

5 a. Prove that $GH^T = 0$ and $CH^T = 0$. **(06 Marks)**

b. The parity check bits for (8, 4) linear block code are generated by

$C_5 = d_2 \oplus d_3 \oplus d_4$

$C_6 = d_1 \oplus d_2 \oplus d_4$

$C_7 = d_2 \oplus d_3 \oplus d_4$,

$C_8 = d_1 \oplus d_3 \oplus d_4$.

Where $d_1d_2d_3d_4$ are message bits. Find G, H minimum weight of their code and draw the corresponding encoding and syndrome calculation circuit. **(14 Marks)**

6 a. Consider the (7, 4) cyclic code generated by g(x), $g(x) = 1 + x + x^3$. Write the encoder circuit and find the codeword for the message 1011, 0101. If the received code z(x) = 1110101, draw the syndrome calculation circuit and correct the single error in the received vector. **(14 Marks)**

b. Explain with neat block diagram, decoding circuit of cyclic codes. **(06 Marks)**

7 Write short notes on :

a. RS codes

b. Golay codes

c. Shortened cyclic codes

d. Cyclic redundancy check codes. **(20 Marks)**

8 Consider (2, 1, 3) convolution code with $g^{(1)} = [1\ 0\ 1\ 1]$, $g^{(2)} = [1, 1, 1, 1]$. Draw the encoder block diagram, using generator matrix find the code and verify the same using transform domain method for the message sequence 10111. Draw the code tree and find the code using code tree. **(20 Marks)**

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